Semi-Annual Progress Report

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Task Objectives

The objectives of the last six months were:

Review plans for EOSDIS

Continue development of local Scientific Compute Facility and prototype information management system

Prepare white paper on ocean color measurements and distribute to the SeaWiFS science team

Continue analysis of sun-stimulated fluorescence data collected off northern California

Prepare an Algorithm Theoretical Basis Document for planned at-launch data products,

Work Accomplished

Project Data and Information System Plans

I reviewed the materials for the EOSDIS Core System (ECS) System Requirements Review (SRR). This consisted of roughly 200 pages of materials. 1 submitted over forty Review item Discrepancy forms about various aspects of ECS. I also attended the SRR itself in September. From both the presentations and the documentation, it was obvious that ECS was in serious trouble. The system was highly centralized in its design with an inadequate understanding of the types of services that the user community would expect from ECS. These concerns were documented in the report of the EOSDIS Advisory Panel to NASA Headquarters.

I subsequently met with several representatives of Hughes in an effort to increase their awareness of the needs of the science community. Although these meetings were useful, there has been little follow-up since then.

My team reviewed and commented on several other documents that were produced by the ESDIS project, including plans for the Product Generation Toolkit. We noted that the PGS Toolkit seemed to be based on popularity of specific items, rather than on a rational plan. For example, if a specific function was requested by only one team, it was deemed to be unimportant. This will lead to a system that will be rigid and difficult to change. The toolkit relies heavily on manual intervention when processing goes astray. Such an approach will be quickly overloaded in an operational environment.

One of the most serious failings of the PGS plan was its apparent firewall between the PGS and the SCF (scientific compute facility). This separation carried over into the SRR where it was noted that the SCF's must be considered as critical elements for EOSDIS. The SCF's must be able to access the various capabilities of the PGS through the use of fully functional toolkits.

Lastly, we provided comments on the Science Software Standards. This document was very disturbing as it wavered between broadbrush issues and irrelevant details. For example, no one can really describe what will be in the PGS Toolkit, yet specific word processors were mandated for documentation. No one seems to be able to take an overall systems view of ECS, and instead we focus on the trivial details that are easy to do. These issues were brought up in the SRR as major flaws in the present design.

Local Scientific Compute Facilities

In the last report, I described a proposal by Otis Brown and I proposed to test advanced networking methods to develop an integrated algorithm processing and validation system for SeaWiFS. This work was to be supported by the Naval Research Laboratory. This proposal has been delayed, but the high-speed links are scheduled to be installed in February. We will use ATM as the protocol to link our CM-5 and the Silicon Graphics machines at Miami.

As part of the National Information Infrastructure Testbed (NIIT), Berrien Moore (University of New Hampshire) and I are developed a prototype data system to test software from Ellery Systems. We developed a prototype system that used a subset of Moore's Landsat data and my AVHRR/CZCS data from the eastern North Pacific. The application was able to search both databases through as single interface. However, a number of technical issues remain, especially in the area of network management. We will continue this work through 1994.

Ocean Color White Paper

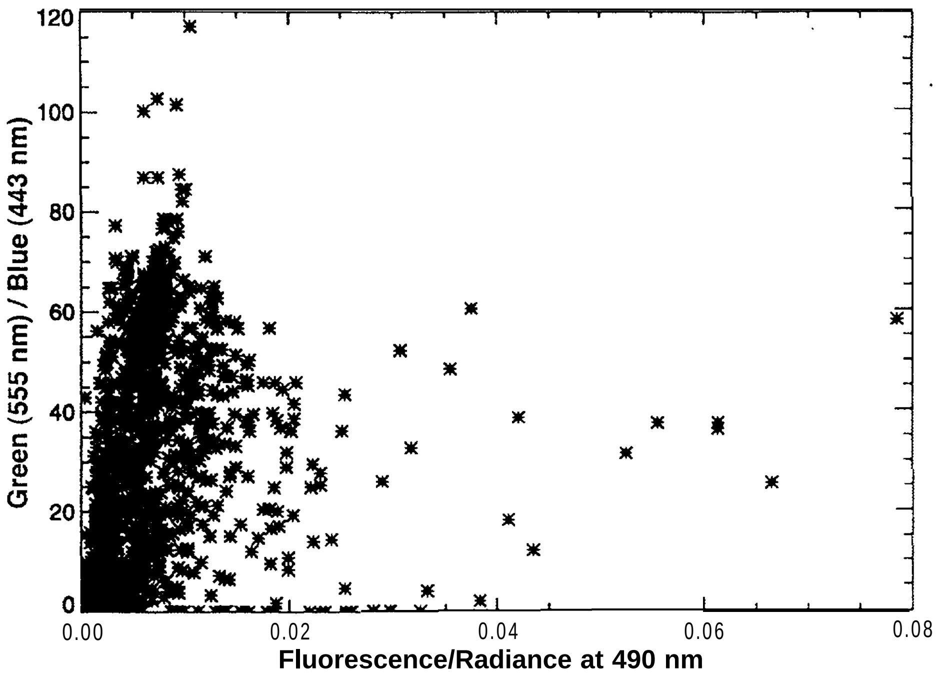
A final draft of the Ocean Color White Paper was distributed to selected investigators in December. This draft included sections on high spectral resolution data sets and on convergence with other ocean color sensor programs. In particular, the next decade should be used to study issues of sampling and measurement characteristics necessary to study the role of upper ocean biology in the Earth's climate. For example, do we need to resolve diel variability in sun-stimulated fluorescence, and if so, what is the optimal orbit strategy? Such studies will require close coordination between Japanese, European, and U.S. ocean color programs beyond simply exchanging data.

Data Analysis and Interpretation

A manuscript describing analysis of bio-optical observations from a Lagrangian drifter has been submitted to J. Geophys. Res. for publication.

I have deployed 15 near-surface bio-optical drifters in the California Current as part of ONR's Eastern Boundary Current study. Figure 1 shows the tracks of the early drifter deployments. As expected, the drifters moved slightly offshore and southward during their lifetime. Two drifters failed early in the deployment because of heavy sea conditions (winds in excess of 20 m/s), but most survived on average of 80 days. This compares favorably with standard World Ocean Circulation Experiment (WOCE) drifters given the extra power drain on the batteries to support the bio-optical sensors. One drifter that was deployed in early September 1993 continues to operate. I plan to deploy nine more drifters (in three deployments) during 1994.

Of particular interest for my MODIS research is the sun-stimulated fluorescence data that has been collected by the drifters. Figure 2 shows the ratio of upwelling radiance from 555 nm to 443 nm plotted versus fluorescence (normalized to downwelling solar irradiance at 490 rim). The radiance ratio is a surrogate for chlorophyll, using the accepted radiance ratio approach developed for CZCS and other ocean color sensors. In general, there is a rough relationship between normalized fluorescence and chlorophyll (as indicated by the radiance ratio), but there is considerable scatter, Thus far, my analysis has not revealed any consistent pattern (inshore versus offshore, etc.), but these results are only preliminary. I suspect that the variability in this relationship between chlorophyll and fluorescence is a reflection of the photoadaptive state of the phytoplankton. It is this information that I intend to use in models of primary productivity,



Information Systems Development

As mentioned in my previous report, Roen Hogg has assumed the role of Information Systems Developer for my group. Drawing on his experience with complex information systems at American Express, Mr. Hogg has developed an object-oriented architecture to cope with the many data types and activities that are part of our research. He is using the ONR Eastern Boundary Current study as a prototype because it includes ship and drifter data, satellite imagery, and numerical model output.

We are using an object-oriented analysis and design of our system based on ParcPlace's Object Behavior Analysis (OBA) methodology. The goal of this methodology is to provide a clear understanding of the behaviors of the system, the objects that exhibit these behaviors, the relationships among the objects, and how the objects interact with one another (the system dynamics).

OBA methodology consists of the following five steps (step O through step 4):

Step 0	Setting the context for analysis
Step 1	Understanding the problem by focusing on behaviors
Step 2	Defining objects that exhibit behaviors
Step 3	Classifying objects and identifying the relationships among them
Step 4	Modeling object and system Iifecycles

In step O we identify system goals and objectives, scope and delineate the problem space, identify appropriate resources for analysis, and generate a preliminary analysis plan.

In step 1 we determine what the system is supposed to do, and to whom and with whom it is supposed to do it. To do this we determine the set of desired and necessary system behaviors and identify the initiators and participants of these behaviors. The final results of step 1 are an Initiator/Participant Glossary and a Participant Services Glossary. The Initiator/Participant Glossary is useful for identifying objects, verifying completeness (by cross referencing with viewpoints), and validating the scripting process. The Participant Services Glossary (sorted by participants) is useful for checking for completeness, identifying where refinements are necessary, and identifying where we can consolidate similar services.

In step 2 we define the objects responsible for the system work. For each object we determine the services that are provided, services that are contracted, and its object attributes. The final results of step 2 are object modeling cards.

In step 3 we identify relationships among the objects that carry out the system work (contracted services). We also identify relationships that describe objects in terms of division of responsibilities and shared services and attributes. And finally, we utilize object-oriented techniques for reorganizing relationships. This provides us with a static system view. The final results of step 3 are updated modeling cards, contract diagrams, object diagrams, and a reorganization table.

In step 4 we identify aspects of the system that change over time. In particular, we identify ordering constraints, capture the system Iifecycle, and capture the Iifecycles of interesting objects. The final results of step 4 are a State Definition Glossary for each object, state Iifecycle for each object with important dynamic behavior, and time and sequencing of operations. The State Definition Glossary is useful to identify states (since states are used/referenced in pre and post conditions) as well as validate the correctness of the scripts by ensuring that all states really do have a pre and post condition.

Context for Analysis

Goals

Analysis Focus

Specific Result -- Develop a particular application, system or product within a given discipline

Business Goals

The objective of the project is to develop a user-friendly system that will allow scientists to interact with oceanic data and test hypotheses at the workstation. In addition, this system will facilitate multidisciplinary ocean field experiments by allowing scientists to communicate the results of their research to internal and external user groups.

In particular, the system will provide the following:

(1) Add quality to the data: The system will maintain a derivation history that will enable scientists to verify previously obtained results by repeating the derivation process.

(2) Speed up time to market: The system will enable users to obtain results faster. This is important from a policy and funding point of view.

(3) Consolidate data: The system will help users understand the earth as a system by enabling users to consolidate different data sets.

(4) Facilitate collaboration: The system will facilitate collaboration among scientist by allowing them to easily share information.

System Goals

The proposed system will provide intuitive and relatively transparent access to existing analysis systems, numerical models, imagery data, data acquisition systems, heterogeneous databases, and communication systems, Given the large disk storage and computing capability (between 2-3 Giga flops) required by existing 3-D modeling and analytical tasks, the system will provide access to the OSU Oceanography computing facilities (SUN Spare and IBM UNIX-based workstations, and a massively parallel CM-5 Connection Machine),

Some of the major features associated with the system include the following:

Derivation Analysis

The system will process requests for the selection and formatting of relevant data, In particular, the system will process requests to transform:

(1) level 1 data (sensor data) into level 2 (geophysical data)

(2) level 2 data (geophysical data) into level 3 data (higher-order data)

Research Analysis

The system will support the research analysis common to all (most) research projects. This includes the following:
(1) useful numerical analysis and display of data sets
(2) useful data queries (e.g., depth, location, data, type)
In addition, the system will store a description of how each data set was derived (analysis history).

Visualization

The system will support graphic and video images. These images will include plots (e.g., profile, time series, drifter, imagery, grids, station), satellite images, and video. The system will provide the following functionality:
(1) interface with the appropriate graphic/video generating programs
(2) store a description of how each image was derived (visualization history)
(3) store any free-form text a scientist wants to associate with a particular image
(4) provide useful query capabilities

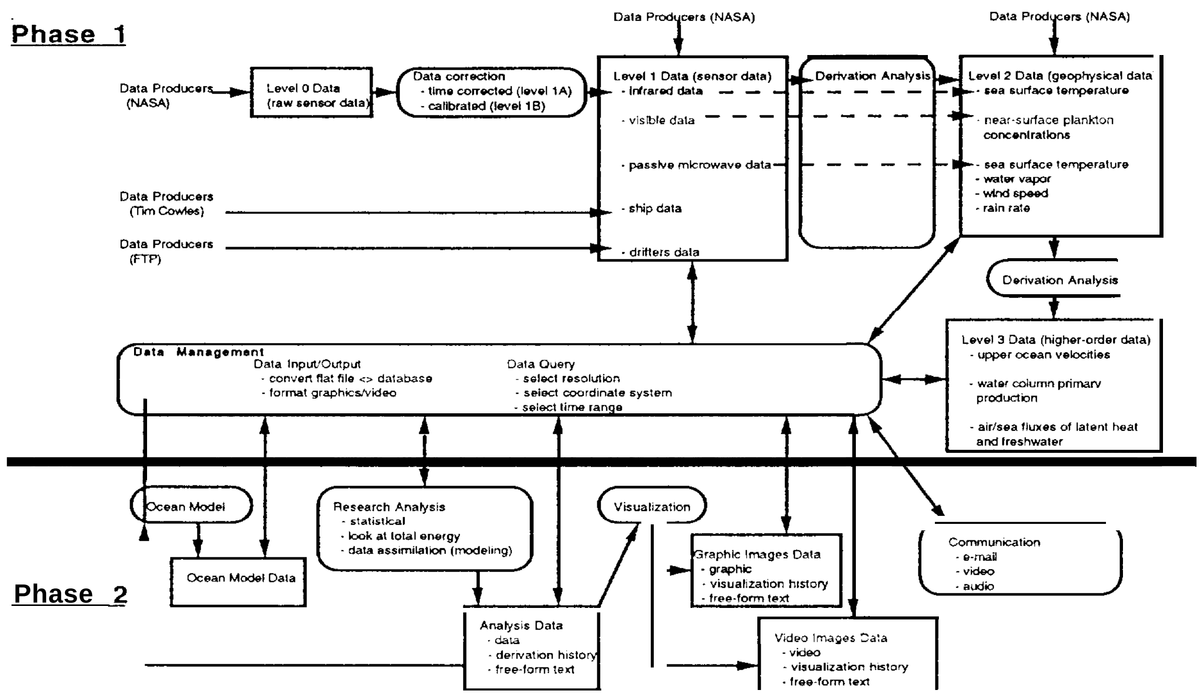
Communication

The system will provide computer networking and transmission of data and results to internal and external user groups. The system will support the following types of communication:
(1) e-mail
(2) video
(3) audio
(4) data (files)

Ocean Model

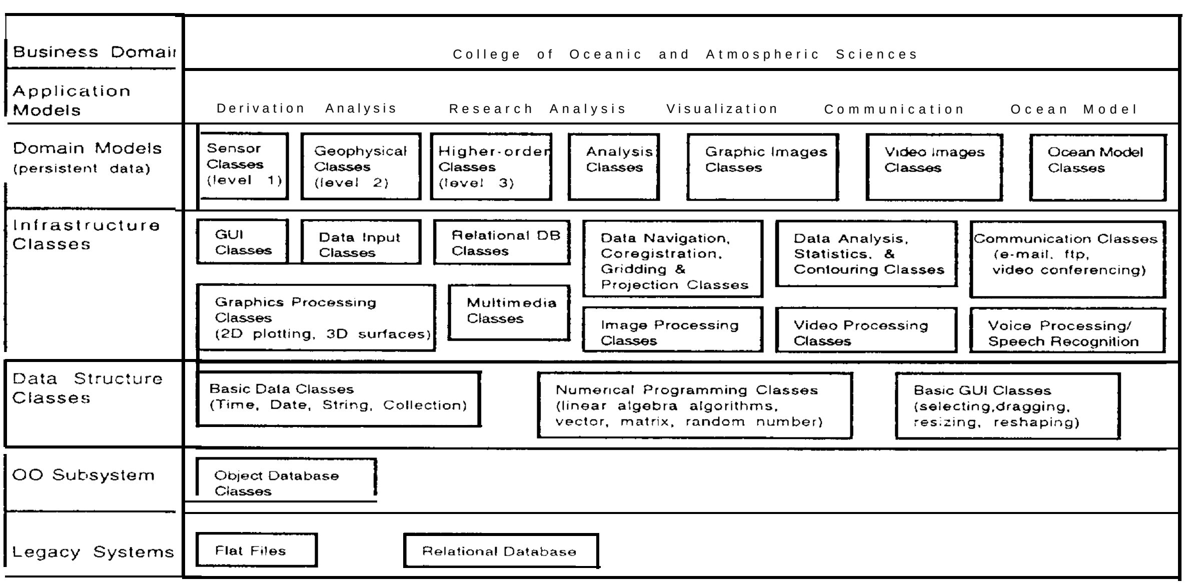
The system will interact with various existing models by providing specifications of input and output parameters.

Below is a diagram of our data flow for this system.



From this description of our data flow, we then defined a layered architecture for the system as shown below.

Layered Object-Oriented Architecture



This information will be used to define the various object classes. This approach has many advantages, but in particular it focuses on separating the persistent data classes from the more rapidly changing services. Such an approach would be particularly useful for ECS. For example, we might expect the underlying level 1 or level 2 data to change much more slowly than the various map projections. The traditional approach views the level 3 data as another separate data set, while this approach views it as just another service (or method) applied to persistent level 2 data.

We plan to develop an initial prototype this spring, and we should have a functional system by fall 1994,

Algorithm Theoretical Basis Document

I have nearly completed my Algorithm Theoretical Basis Document (ATBD) as requested by the MODIS team leader. I am focusing on the fluorescence line height parameter as an at-launch product. Daily primary productivity will require considerable research between now and launch so the associated ATBD will be much less mature.

Unfortunately, conflicts with other EOS and EOSDIS reviews have slowed my progress on the ATBD, but I expect to have a complete version by mid-February 1994.

Anticipated Future Actions

I will continue to review various EOSDIS documents as they appear. Although the situation with ECS has improved somewhat since the SRR, there must continue to be active communication between the contractor and the science community.

I will continue to analyze the ocean drifter data, especially the data on sun-stimulated fluorescence. As noted above, I plan three more deployments in 1994.

Mr. Hogg and I will continue to develop our object-oriented information management system. We will have a working version by summer 1994.

With Bob Evans and Art Marinaro (Univ. Miami), I am still planning on using optimal assimilation techniques to fill in data “gaps” in CZCS imagery using the Thinking Machines CM-5. The Miami researchers have had other obligations which has slowed down this work.

I have hired a postdoctoral researcher (Dr. Ricardo Letelier, Univ. of Hawaii) to work on primary productivity modeling using fluorescence data, Dr. Letelier will join OSU in May 1994. He comes highly regarded in the area of phytoplankton ecology, having worked on the Hawaii Ocean Time Series as part of the U.S. JGOFS program. He will bring considerable expertise to my research, and I am anxious to have him start work here.

Problems and Solutions

At this point, my main concern remains EOSDIS, I am not convinced that the system will have enough felxibility to incorporate changes in scientific understanding and requirements over the lifetime of the mission. I worry that decisions are being made today based on inadequate or incorrect information. It may be veru difficult to change the system as technology and user requirements evolve. It is clear that the situation is better than last September, but the science community must continue to monitor the progress of EOSDIS.

I am also concerned with the approach that the EOS Project Office has taken for peer review of algorithms. There has been no coordination with the EOS investigators Working Group